INDIVIDUAL IDENTIFICATION OF HARBOR SEALS FOR APPLICATION TO POPULATION AND BEHAVIORAL STUDIES

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INTRODUCTION

Harbor seal pelages are marked with a variety of spots and rings on contrasting light and dark backgrounds (Stutz 1967, Shaughnessy and Fay 1977, Kelly 1981). The patterns are individually unique but constant in shape and location throughout time (Stutz 1967, Yochem *et al.* 1990, Daniel unpublished, Kelly unpublished). These characteristics of harbor seal pelage present the opportunity to identify individuals within a population. Attempts have been made in the past to develop methods that utilize the uniqueness of both grey seal and harbor seal pelage patterns to identify populations and individuals (Hiby and Lovell 1990, Yochem *et al.* 1990). The use of photographic identification has great potential for mark/recapture studies. In this paper we describe a method to identify individual harbor seals in black and white photographs. A scheme for classifying the ventral pelage of harbor seals was developed to facilitate the initial sorting of photographs. We developed an efficient system for matching photographs of the same individual using a relational database analogous to that used in photographic identification of humpback whales (Mizroch *et al.* 1990). We tested the method using 1,940 photographs gathered in 20 hours of field time in 1997 and 1998 on Tugidak Island, Alaska.

METHODS

Acquisition of photographs

The ventral surfaces of harbor seals were photographed on 7 days between the August 27 and September 7 in 1998 and on 15 days between August 16 and September 18 in 1999. Photographs were taken from bluffs 15-30 meters above seals on the southwest shore of Tugidak Island, Gulf of Alaska. The distance of the seals from the photographer ranged from approximately 45 - 65 meters. Photographs were taken with black and white film (ASA 400-1600) using a Nikon F3 35mm camera mounted to a Celestron C8 40x telescopic lens. Negatives were digitized onto a photo CD and

converted to bitmap images with a batch routine for attachment onto a data form in Microsoft Access.

Categorization of photographs

Each photograph of a seal was categorized by: sex (male, female, unknown), discrete color phase (light, dark, and intermediate) (Kelly 1981), spot to background ratio of light phase seals (5 gradations), spot complexity of light phase seals (3 gradations), and ring density of dark phase seals (5 gradations). Spot complexity was the degree to which the majority of spots deviated from a simple oval. There were three gradations ranging from simple oval spots to complex branching spots. We minimized differences in inter- and intra-observer scoring of spot to background ratio, spot complexity, and ring density by recording the first and second most likely gradations for each category. The scores for each of these categories were entered into a relational database (Microsoft Access). The digitized image of an individual seal was embedded onto the form containing the data for that seal.

Searching and matching of photographs

Matching two photographs of the same seal was a two-step process. First, we queried the database to determine if the seal had been identified previously. The categorical descriptions (Figure 1 and 2) were used as search criteria. Queries filtered the database so that the subset of previously entered photographs that could possibly match the new image was displayed to a computer screen (Figure 3). In the transition between each categorical step, database queries reduced the number of possible matches. For example, if the seal photograph in hand was female then all male seals were removed from the first subset of possible matches. The seal was then categorized by discrete color phase. If the seal was light phase then all dark and intermediate seals were removed from the next subset of possible matches. The seal was then categorized by spot to background ratio. If the seal was scored as gradations one and two, then gradations three, four, and five were removed from the subset of possible matches. The end result of the database queries was a small subset of images that potentially matched the new image (Figure 3). In the second step of the process, the subset of possible matches was displayed to a computer screen. The new photograph was then visually compared to the subset of possible matches displayed on the screen.

RESULTS

A two-person team acquired 781 photographs of seals in 1998 and 1,159 photographs of seals in 1999. There was an average of 839 seals on the beach during each sampling period, but no attempts were made to photograph every seal in the group as pictures were taken opportunistically when time allowed between other duties. One to three photographs of an individual seal were taken during a sampling period as a precaution against poor photo quality. The 1998 sample included 363 unique individuals. We photographically captured the ventral surface of approximately 25% of the seals in sampled groups. We entered categorical descriptions (sex and pelage) into the database at a rate of <1.5 minutes/photograph. We were able to check 100-120 new photographs for matches in the database in one day. Of the seals captured in 1998, 26 were recaptured on a different day of the same year and 43 were recaptured in 1999.

DISCUSSION

Photographic identification of individuals has been used frequently in cetacean studies (Mizroch *et al.* 1990, Bigg *et al*. 1987, Childerhouse *et al.* 1995), but its application to pinnipeds has been limited (Hiby and Lovell 1990, McConkey 1999, Yochem *et al.* 1990, Smith and Hammill 1981, Olesiuk *et al.* 1995). Hiby and Lovell (1990) described a method to identify patches of pelage patterns on the head and neck of grey seals. That method used a computer to create a three dimensional model that can be scaled, enhanced, and rotated to a standardized plane to identify a particular patch of pelage. The application of this method to harbor seals is being developed and reported elsewhere in this volume (Hastings *et al.* 2001). The method relies on complex computer software and mathematical models to match seals and is not available to those with limited budgets or resources. Our method relies upon widely used relational database software and can be set up and used by persons on limited budgets and resources. Both methods are currently being developed and a thorough comparison of the two methods has not yet been performed.

Yochem *et al.* (1990) developed a classification scheme of non-metrical pelage characters that were used primarily to detect differences in stock and population characteristics of harbor seal pelage. They used several different body areas on the dorsal and lateral sides of the seal body to categorize seals. We developed a method with the primary objective of identifying individuals for the future application to population studies. Our method concentrates identification to the ventral surface that provides the sex of the animal, important information in population studies. The ventral surface was also chosen because pelage markings appeared to be especially informative and favorable for distinction by the human eye.

We have demonstrated that human observers can readily recognize individual seals based on pelage markings and that a relational database can be queried effectively to facilitate the filtering and matching of photographs. As the database continues to grow, further development of the methods will be required to aid in the narrowing of the pools for ultimate visual identification.

The number of matches may have been higher if the timing of the sampling periods had been standardized. This work was performed as a side project to on-going population studies and photographs were taken as a second priority. In 1998, the majority of photographs were taken on 7 days between August 27 and September 5. In 1999, photographs were taken on a total of 15 days between August 16 and September 18. Harbor seals on Tugidak Island begin molting in mid-late July and molting is completed in mid-late September. The timing of the molt differs by age and sex class. Younger seals (yearlings and subadults) begin molting first, followed by adult females, and lastly by adult males (Daniel *et al.* 1999). Differences in the timing of our sampling period in conjunction with differences in the timing of molting among harbor seals may have influenced the number of matches between years.

Mark and recapture methods such as tags, paint, and brands have been used widely in population studies to estimate such information as population size, productivity, and rates of age specific survival. The main obstacle in many mark/recapture studies is the feasibility of marking large numbers of animals. The efforts often involve a large expenditure of energy and resources for a relatively small number of marked animals. Marking large numbers of animals can also be logistically problematic and involve large disturbances to animals. Photographic identification is a non-invasive method that "marks" large numbers of animals with little energy and resources relative to other mark/recapture methods. The time required to acquire photographs, enter data, and search for matches is small relative to the information gained.

ACKNOWLEDGEMENTS

We thank the Alaska Department of Fish and Game for funding and logistical support, Bob Small and Lauri Jemison for their support of this project and other projects on Tugidak Island, and the Natural Resources fund of the University of Alaska for funding support. We thank Sally Mizroch for her advice and guidance in the development of this project, and Kelly Hastings for help photographing seals. We also thank Beth Mathews, Dion Oxman, Oriana Harding, Stephanie Haverlack, Lauri Jemison, and many University of Alaska Southeast students for providing comments and suggestions and scoring seals in the initial development of pelage categories.

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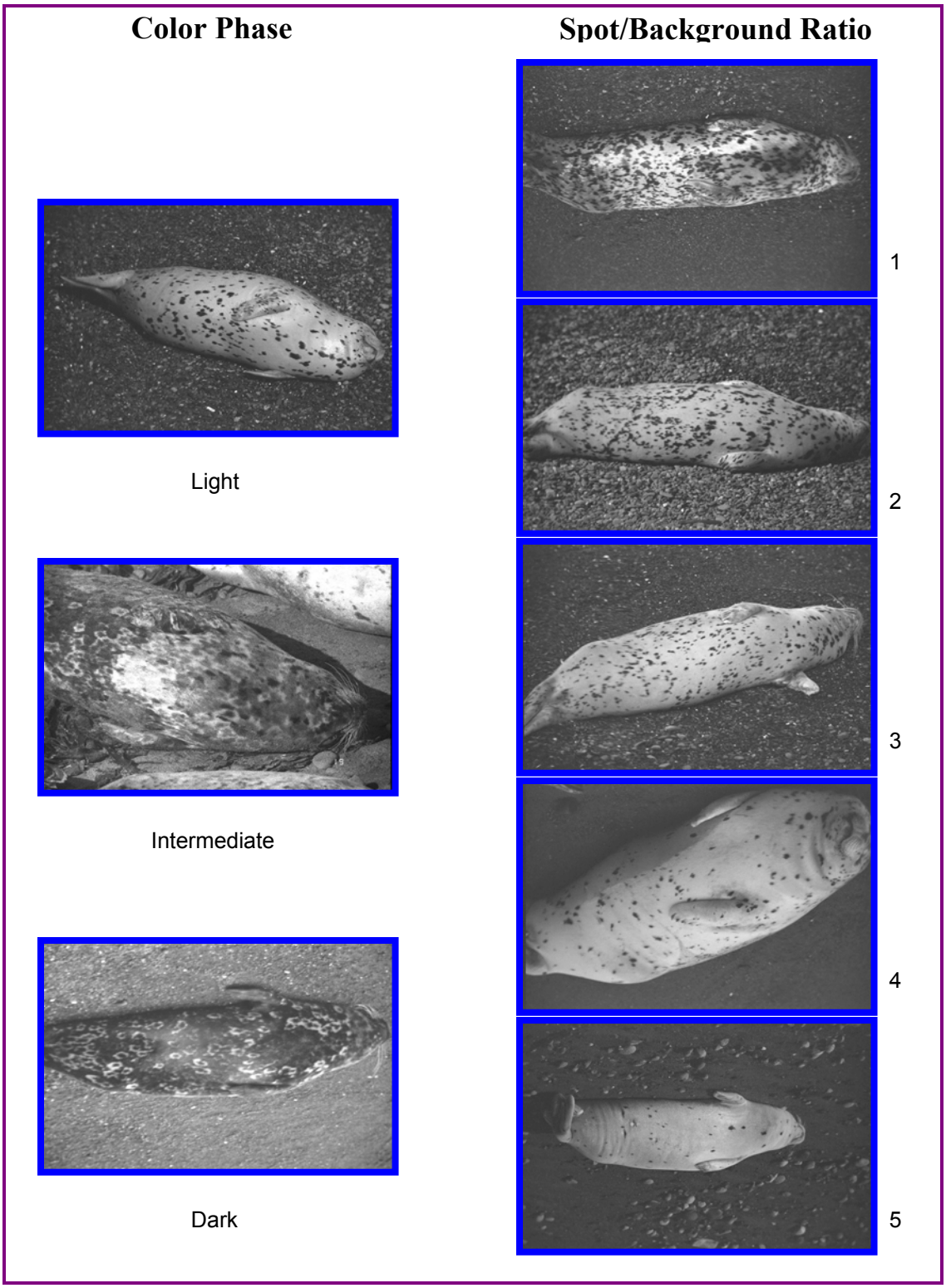

Figure 1. Color phase and Spot to Background ratio categories for the classification of harbor seal pelage.

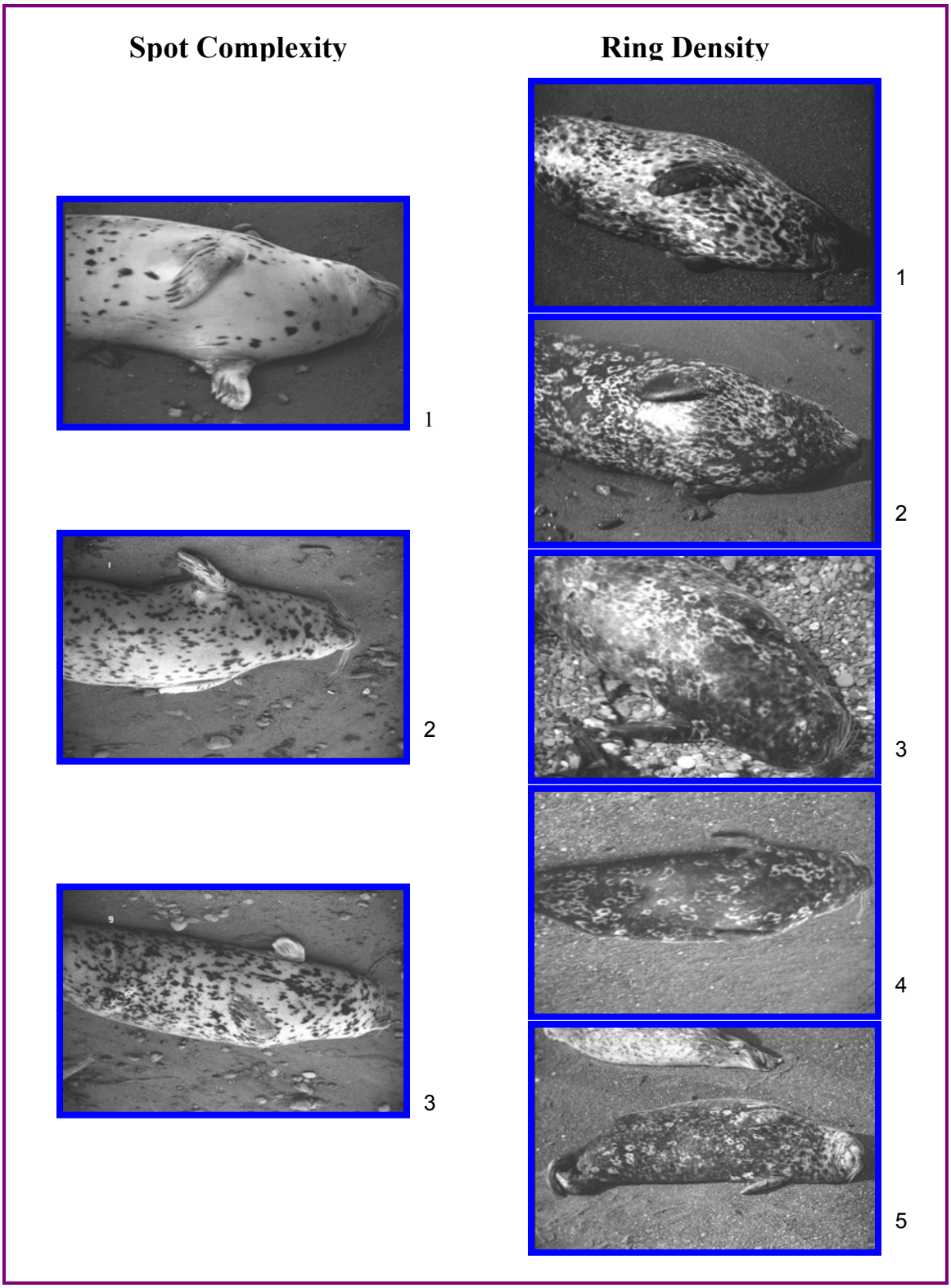

Figure 2. Spot Complexity and Ring Density categories for the classification of harbor seal pelage.

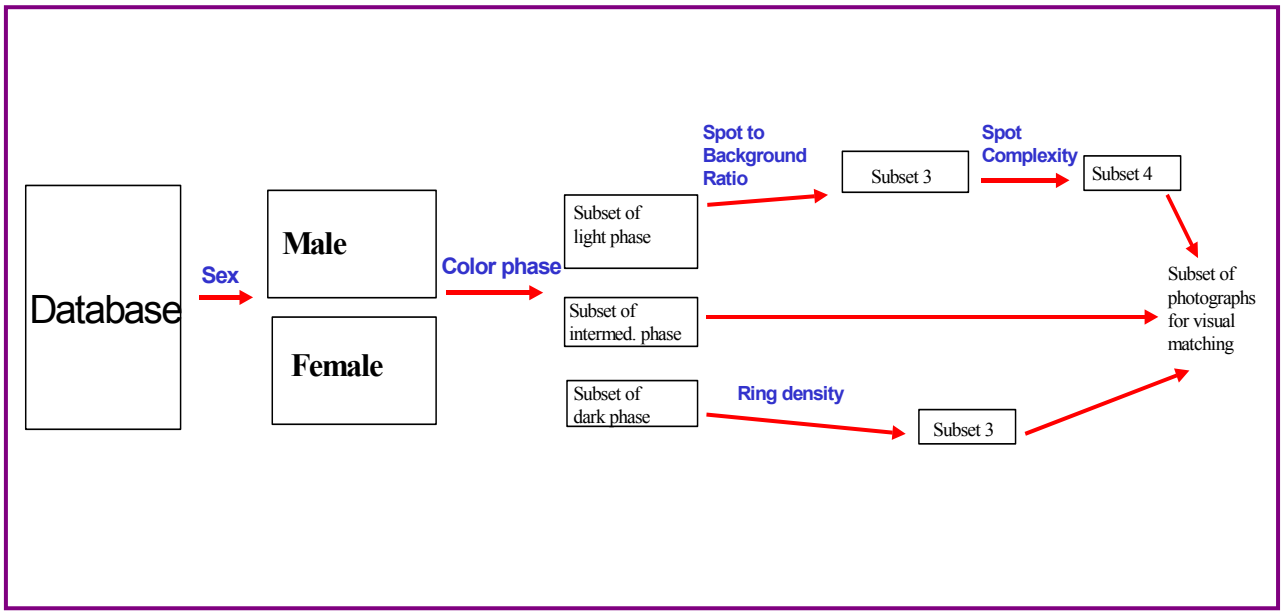

Figure 3. Schematic diagram displaying the sequence for categorizing a photograph of a harbor seal. In the transition between each step, database queries reduce the number of possible matches. The end result is a small subset of photos that can be visually compared to the new photo.